TELE-MEDICINE APPLICATIONS OF AN ISDN-BASED TELE-WORKING PLATFORM

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Abstract-**The Tele-Medicine sub-services backed up by a novel, open-architecture Tele-Working platform, are evaluated. This multimedia platform, developed over the Hellenic Integrated Services Digital Network (ISDN), is based on user terminals (personal computers), networking apparatus, and a central database. The developed product equips the Hellenic PTT Organization (OTE) with a ready-to-be applied novel service that would supply future subscribers (MDs) the means to remotely collaborate in real time, exchange data on- and off-line, enhance their diagnoses, electronically fix, accept, or modify patient visits, 'build' virtual rooms to meet, etc. The platform, especially focused to implement a Tele-Medicine system, was tested for a period of over nine (9) months through a network of twenty-two (22) nodes situated in remote counties of Hellas.**
***Keywords*-Tele-Medicine, ISDN, Tele-Working**

I. INTRODUCTION

Tele-Working has been trying to establish itself as a dynamic means to exploit technology for more than a decade [3]. It addresses a cooperative-work problem, the exchange of data between the computer systems of institutions or public administration, and geographically distant users, free lancers, or employees [9]. Currently, it is the cornerstone of a number of successful global companies, either providing or utilizing new technologies. According to some analyses, its future lies with 'trusted third parties' that combine data management and public key infrastructure, ready to offer enhanced message switching and translation in response to market trends [8].

Three (3) years ago, the Hellenic PTT (OTE) and the University of Patras started a large-scale common project aiming to implement a special value-added ISDN service [10]. The project should outcome to both an integrated Tele-Working platform, a main central database (completed with maintenance facilities), and a ready-to-be-applied service that was to satisfy the demands of possible future subscribers. Also, a focused implementation of this platform was designed to cover the needs of MDs, forming a Tele-Medicine service.

As a result, the new service was developed so as to fulfill a number of requirements: set-up a closed group of MDs with the unique ability to take advantage of the service; extend remote collaboration in real time by means of audio/video/data communication; provide internet-like characteristics like site-building for education purposes and electronic mailing facets; guarantee high quality of service and level of security. All above treats had to also take care of fast connections.

Session II deals with the architecture of the Tele-Working Service, Session III refers to some Tele-Medicine facets, Session IV presents figures evaluating the service, and Session V handles general telematic perspectives.

II. ARCHITECTURE AND GENERAL CHARACTERISTICS

2.1 Architecture

The platform has been implemented in two phases. During the *first phase*, an investigation concerning future subscribers' daily practice was performed as a large-scale market research.. Sampled people originated from both the private and public enterprises, with a focus to the former ones, in an effort to support private initiative.

In order to gather premises for a Tele-Working service, OTE advanced collaboration schemes in the form of value-added services that are based on closed user groups, where the user access is strictly authenticated. Future subscribers seemed to prefer simple and friendly terminals (e.g. PCs instead of workstations) including facilities for the organization and the fast and secure handling of users files. Moreover, they also require a service modular architecture consisting of different levels of facilities thus implying diversified operational costs.

During the *second phase* of the Tele-Working platform development, a generic architecture was designed and the service was implemented. This provided for an integrated working domain including tools for the composition of dial-up multiparty co-operation schemes (Tele-Working group).

The key points of the architecture are as follows:

- The network substructure includes one (1) router, which is connected to a PRI (30B Channels) and is used for the establishment of dial-up ISDN connections between the users and central data base, combinatorially accessing base, combinatorially accessing from one (1) to six (6) B-channels, according to the terminal equipment.
- Network Support and Surveillance are supplied by OTE.
- The Communication Entity satisfies standard ITU protocols [1], [2], and [4].
- The Administration Entity bridges the interoperability of the server, the calls, and the router connections according to the demanded and free to give server B-channels.
- The database incorporates maintenance tools as well.
- The user's interaction with the proposed platform is facilitated by the usage of multimedia information technology and visual programming, which provides for interactive user-interfaces. Also, software tools for data management and handling, exchange of multimedia data (audio/voice/data) support, etc. are also integrated.
- A Network Terminal connects the PC to the ISDN.
- The PC-ISDN router handling up to three (3) ISDN BRIs.

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Abstract

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- PC set-up. Special communication software has been designed to deal with the administrational and the application needs of the Tele-Working platform.
  The software includes procedures that implement operational scenarios depending on particular needs.
- The user interface supports Tele-Working applications, especially those that are independent of the telecommunication and operational infrastructure.

The aforementioned entities are responsible for the on-line and off-line use of the Tele-Working service and support transfer rates up to 384Kbps. Their implementation follows the H.320 and T.120 ITU-T recommendations (on-line use), and the LDAP (X.500) and SMTP (X.400) protocols. TCP/IP handles off-line file transfer.

2.2 General Characteristics

The Tele-Working platform provide for the services [2]:

- Patients Record Handling: Composition and Sending; Delivery, Reading, and Storing; Replying;
  Forwarding (to another MD); Waiting lists; Distribution lists; automatic procedures for Delivery and Reading.
- Operational clinics scheduling.
- Conferencing: Chat-like (in virtual rooms) and tele-conference conventions, with on-line collaborative medical image processing tools.
- A patients' Catalog.
- Subscribers' (MDs) data Handling: Insertion, Modification, Finding, Storing, and Deletion.

The following target groups were selected:

- Remote/collaborative (tele-)working MDs.
- Information retrieving activities.
- Tele-Education (in medicine) networks.
- Health-care providers.
- Tele-Attendance of surgical operations.

Fig. 1 offers a schematic representation of the service.

III. TELE-MEDICINE

Public health services in Hellas are organized in a three (3)-level scheme: family MD (cures simple cases and, if need be, suggests the conveyance to a Health Center); Health Centers (where analyses are performed or prescribed).

General Peripheral Hospitals are the final step in health care and mostly handle surgical interventions. There is a Health Center in every county or/and big urban center and a General Hospital in every prefecture. However, the people living in rural areas have often to travel rough roads or cross the sea to get to a near Health Center or a General Hospital.

The Tele-Working platform was thus focused on Tele-Medicine needs. The key-points of the service are [10]:

- 128 - 384 Kbps transfer rate.
- Very operational graphical user interface due to the lack of familiarity of MDs versus PCs utilization.
- Organized office (patient file, capturing of analyses' results, tracking of patient visits to the MD, etc.).
- Medical Image Processing (tools including filters, extraction of ROIs, etc.), both off- and on-line.
- Real-time conference with real-time data exchange.

Fig. 2 shows the functional and networking connections between the offered Tele-Medicine sub-services, the utilized Tele-Working facets outward from a Hospital's LAN.

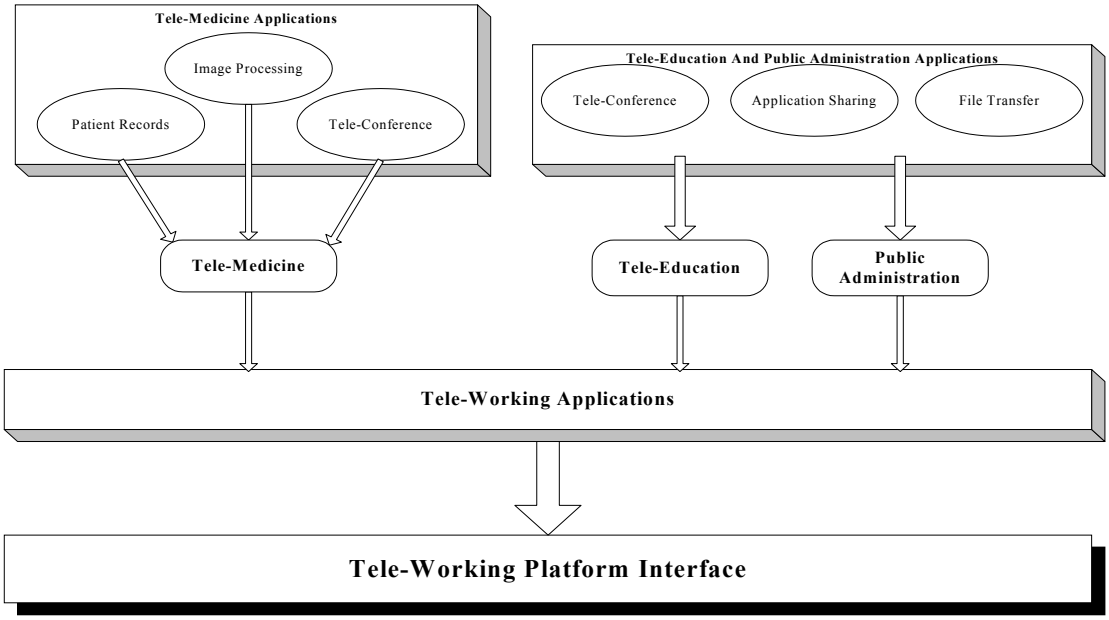

Figure 1: Tele-Medicine Service Schematic Representation

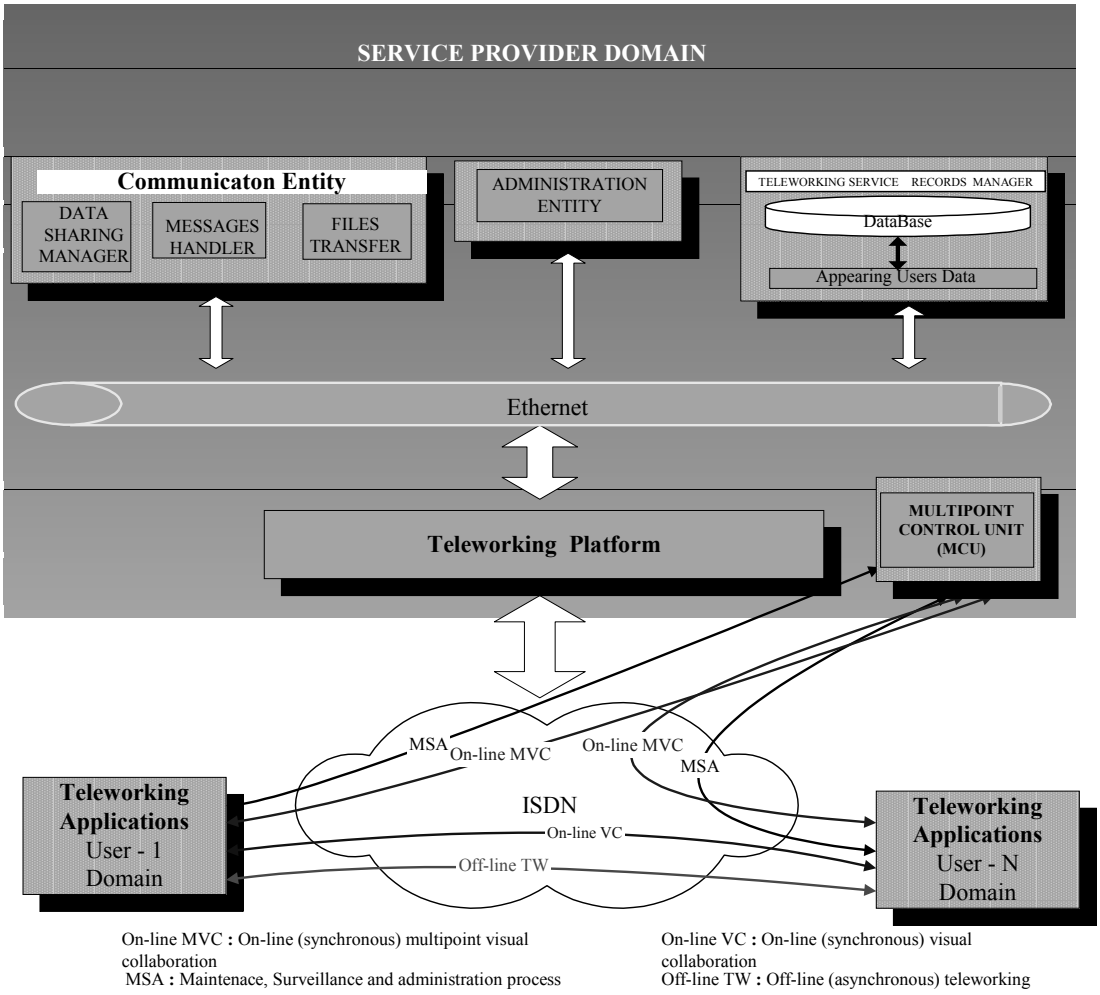

Figure 2: Linking a Hospital's LAN to the ISDN by means of a Tele-Medicine service

MDs were taught by on-the-spot two (2) day seminars that were organized, and later on supported by OTE technical staff. More difficult matters were treated by real-time conferences between the platform's developers and MDs.

IV. Evaluation

The pilot project for the Tele-Medicine service, extended to 22 nodes (16 Health Centers - 6 General Hospitals) of Epeirus and Thessaly. For this period time 265 test and real medical cases were serviced (75/190 ratio), they consisted of 213 laboratory examinations and 505 medical images. A total of 112,459,591MB were exchanged (to and from) between Health Centers and General Hospitals.

Usage time during collaborative sessions was 90min, in average. The topics covered were 72% medical in nature, 9% administrative, 10% financial, and 9% social talk.

Table 1 shows how MDs judged the service's performance. All answers were positive; the best ratio was achieved for the one regarding execution time.

Service reliability rated second, whereas recover capability regarding the service's and MDs' errors were satisfactory. System resources management was also well accepted.

	Rates		
	(-2)+(-1)%	0%	(1)+(2)%
Response/Task execution time	0	4	96
System Reliability	8	12	80
Recover Capability/ /Terminal Errors	12.5	12.5	75
Recover Capability/ MD Errors	4.2	16.7	79.2
System Resources Management	4.3	17.4	78.3

Table 1: Service's Performance Rates

In Table 2, 77.3% of the users found that on-line help was useful and easy to handle. The user documentation was found understandable and handy by 96% of the users.

	Rates		
	(-2)+(-1)%	0%	(1)+(2)%
On-line Help	9.1	13.6	77.3
User Documentation	0	4	96

Table 2: Manuals and On-line Help Rates

As shown in Table 3, 100% of the answers certifies that the quality of images captured, processed, and transmitted were very good. The illumination of the rooms was adjusted properly, in order to have clear video capture. Answers corresponding to Audio/Video quality were also good, only limited by the used standard A/V equipment. The implemented graphical user interface was positively rated too.

	Rates		
	(-2)+(-1)%	0%	(1)+(2)%
Medical Images Handling	0	0	100
Video quality	0	20	80
Sound Quality	0	12	88
Quality of User Interface	0	8	92

Table 3: Quality of Multimedia Agents

In Table 4, the conference, image processing, and agenda utilities were judged very good, while MDs found satisfaction in collaborating for diagnoses and utilizing the patient file.

	Rates		
	(-2)+(-1)%	0%	(1)+(2)%
Conference	0	4	96
Real Time Image Processing	0	4	96
Agenda	0	4	96
Diagnosis Enhancement	12	0	88
Patient File	4	8	88

Table 4: Tele-Medicine Service's Tools

As shown in Table 5, the learning process of the system is comprehensive for almost all the users. The main functions were rapidly learned, while the advanced ones somewhat less. The requiring time for learning and exploring the full capabilities of the system, was also good. MDS, generally, asked for more time to acquaint with the terminal station.

	Rates		
	(-2)+(-1)%	0%	(1)+(2)%
Learning Process	0	4	82
Main Functions	0	0	88
Advanced Functions	0	4	72
Learning Time	4	4	92
Exploration	8	0	92
Required Actions	4	12	84

Table 5: Functions Learning

Table 6 shows the results related on collaborative sessions. MDs found the connection process and the needed time good. On Data operations -both file transfer and application sharing- they were satisfied. Utilization of real time communication and sharing tasks was also positive.

	Rates		
	(-2)+(-1)%	0%	(1)+(2)%
Connection process	0	12	88
Connection time	0	8.3	91.7
Real Time Communication	0	0	100
File Transfer	8	8	84
Sharing Tasks	0	0	100

Table 6: Cooperative Sessions

V. Discussion

In the Tables of the previous session, MDs of the pilot nodes embraced the new service in general. Notwithstanding their disquietude towards computers, networking equipment, and the other needed apparatus, they exhibited a genuine enthusiasm about the perspectives the service brings along.

After nine (9) months of continuous use of the terminal stations, they ask for enhanced medical images processing tools, increased speeds, linking more General Hospitals in the network, continuing the whole project in a regular basis.

Their necessity to constantly get informed about medicine advances, tele-conferencing major experts in a field, virtually attending seminars, create, and learn from special set-up distance learning educational productions, they believe can be met from the presented Tele-Medicine Service. On the other hand, the overall cost for installing, upgrading and maintaining such a service (and a Tele-Medicine Network), is much less than the cost of the ISDN calls transacted.

Tele-Education is the next agent that will be integrated in the Tele-Working platform, at first focused on Medicine.

VI. Conclusion

The developed Tele-Working platform for the Hellenic PTT (OTE), was focused in Tele-Medicine for establishing a service and other applications that may spring from its use in a flexible, user friendly, foolproof, fruitful, and most convenient manner. It seeks to convey unexploited resources and to combine high-end technological solutions, chiefly in rural, remote regions where no other MDs collaboration is available.

Traits of the platform and service such as its adaptability and promptness so as to satisfy work demands, are going to be enhanced by future, Tele-Centers. They will all combine the many, disparate subsets (small networks) of the main platform.

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